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Growth of Red Pine Trees After Chemical Suppression of the European Pine Shoot Moth

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Growth of Red Pine Trees After Chemical Suppression of the European Pine Shoot Moth

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Abstract

Height growth and number of side branches developing the first growth season after chemical suppression of the European pine shoot moth, *Rhyacionia buoliana* (Schiff.), were measured on 40 treated and nontreated plots of red pine, *Pinus resinosa* Ait., in Michigan. Some plots had been treated during the summer-treatment period and some during the spring-treatment period. Summer treatment increased the height growth and number of side branches over no treatment; the degree of chemical suppression was useful in estimating tree growth during the following growing season. In contrast, spring suppression had no effect on height growth and number of side branches.

Introduction

The objective of most insecticidal treatments in agriculture and forestry is to increase or improve the yield of some crop. Such treatments are not often evaluated in yield terms, however; the degree of pest population reduction is the standard yardstick, presumably because it is more direct and convenient to measure.

For the European pine shoot moth, *Rhyacionia buoliana* (Schiff.), subsequent growth of trees would seem a meaningful measure of the success of insecticide treatments. Populations of this insect can be reduced successfully with insecticide treatments either in the summer when moths are emerging and larvae are hatching (late June to early July), or in the spring when the partly grown larvae are resuming their feeding (April) (Butcher and Haynes, 1960). In the study reported here, we measured two aspects of tree growth the first year following a series of insecticide treatments. The results give some insights into the tree-protection value of different seasons of treatment and different degrees of suppression.

For this study to be undertaken, areas were needed where known insect reductions followed chemical treatments. From 1956 through 1958, entomologists of the Lake States Forest Experiment Station made experimental chemical applications in Michigan for European pine shoot moth suppression in forest plantations of red pine, *Pinus resinosa* Ait. (Miller and Haynes, 1961). Their experiments resulted in many plots with different degrees of population reduction. Some of these had been treated in the spring and some in the summer. These plots provided the data for the study.

Methods

Over 100 plots in four plantations were available, including check plots that had received no treatment. These plots varied in size from rows of 25 trees to 1-acre blocks of trees. The spring and summer insecticide treatments had been assigned at random to them, with no plot having been treated more than once during the same insect generation.

All plot figures for percentage population reduction in each experiment were [illegible]ed, using Duncan's (1955) multiple-range test. The plot in each range with [illegible]reatest reduction from the nontreated plot was singled out. By this operation, 40 plots were obtained; these fell into the following categories:

[1]At the time of this study the authors were located at the Station's East Lansing, Mich., field unit, maintained in cooperation with Michigan State University. Mr. Talerico is now with the Northeastern Region of the Forest Service, Upper Darby, Pa., and Mr. Heikkenen is with the University of Washington, Seattle.

Season of treatment	*No. of treated plots*	*No. of nontreated plots*
Summer	11	8
Spring	13	8
Total	24	16

The plots were distributed along the suppression scale as follows, with extremes in suppression being especially well represented:

Percentage of population reduction	*No. of plots treated in--* Summer	Spring
0- 20*	8	8
21- 40	1	1
41- 60	1	1
61- 80	2	6
81-100	7	5
Totals	19	21

*All plots in this category were check plots.

The season's growth that was affected by the suppressed shoot moth generation was measured on each of the 40 plots. On spring-treated plots, this growth took place the same calendar year and growing season as the treatment since buds elongated in the weeks immediately after treatment. On summer-treated plots, however, the next calendar year's growth was involved because the protected buds did not begin elongating till the next spring. Only one year's growth could be considered because the plots were invaded the year after treatment by moths from surrounding nontreated trees.

Starting from an arbitrary point in each plot, every second tree in a row was taken until there were 10 sample trees per plot. The following attributes of growth were measured for the appropriate year: (1) stem internodal distance — also referred to in this paper as "elongation" and "height growth" — to the nearest inch, and (2) number of side branches at the top whorl. The stem internodal distance was measured because it reflects interrupted height growth — one of the most important types of damage resulting from shoot moth feeding. The number of side branches, which seems to be a good index of shoot moth infestation level (Talerico and Heikkenen, 1962), was measured as a supplementary gauge of tree response to insect suppression. Field work was done during the summer of 1959 when the trees were 10 to 12 years old.

Because the 40 plots were not all treated the same year and came from four plantations, deviations of plot means from the plantation mean for the given year were analyzed rather than the plot means themselves. Tests revealed significant differences between summer-treated and nontreated plots in both growth attributes. This was not true, however, for the spring-treated plots.

Data from the summer plots were analyzed further to determine if the amount of growth in the growing season after suppression could be reliably estimated when the degree of suppression was known. The linear regression model was used, and a significant reduction in the variation among plots in growth attributes was found.

Results and Interpretation

On summer-treated plots there was a definite growth differential over the nontreated plots. *Furthermore, the degree of suppression was found to be useful* in estimating the growth. The coefficients of determination show that from 43 to 50% of the variation in the two growth attributes considered was accounted for by changes in suppression level. In the span of summer suppression levels from

0 to 100%, stem elongation ranged from about 9 to 14 inches and number of side branches ranged from about 1 to 3. Thus, complete suppression resulted in about a 60% increase in the next year's height growth and a three-fold increase in number of side branches, with growth improving proportionately to degree of suppression. Clearly, the growth benefits of summer suppression are due to the elimination of insects at the beginning of the generation before they can do very much feeding.

Turning now to spring-treated plots, neither stem elongation nor number of side branches proved to be affected by shoot moth suppression. The most likely explanation is simply that the trees had already been injured by larval feeding during the summer before treatment. Infestation levels had, in fact, been measured the summer before in three of the four areas where spring-treated plots were established and they averaged 94 infested tips per tree. Almost certainly this infestation level is capable of injuring young trees to a point that would mask any growth benefits resulting from reducing the population the following spring.

Suppression percentages have little meaning unless they are considered along with actual population levels. For example, at relatively low population levels causing little injury, a high percentage reduction would not likely result in any measurable growth improvement. Similarly, at extremely high population levels, a high percentage reduction might still leave enough insects to inflict maximal injury and prevent growth improvement. The relation of growth to suppression level must therefore be considered in conjunction with the population levels on the study plots. The check-plot populations for summer-treated plots ranged from 59 to 132 infested tips per tree and averaged 88; and for spring-treated plots they ranged from 18 to 45 insects per tree, averaging 31. Had we been dealing with lower, higher, or wider ranging population levels, the outcome of this study might have been different.

Where conditions favor build-up in a plantation, a sparse population can become damagingly dense in as little as three years (Heikkenen and Miller, 1960). If build-up is expected from survivors of a chemical treatment — and it usually is — then a summer treatment would seem able to protect the trees one growing season longer than a spring treatment because of the advantage of killing insects early in the generation. On the other hand, suppressing the insect at either treatment season to levels low enough to retard build-up, or prevent it altogether, could result in many years of healthy tree growth. Of course, still other factors can dictate season of treatment. For example, excessive brush in forest plantations can hinder summer spray coverage (Miller and Haynes, 1961). Also, where the situation warrants it, spring treatment can knock down population levels and thereby reduce impending adult dispersal.

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